
# The Coyle Report:

## A Comprehensive Pentagon Study Criticizing the National Missile Defense Test Program

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**Prepared for Rep. John F. Tierney**

**Minority Staff Report**
**Special Investigations Division**
**Committee on Government Reform**
**U.S. House of Representatives**

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**Executive Summary**

An unclassified Pentagon report raises significant concerns with the national missile defense program. The report was compiled by Philip Coyle, the Pentagon's chief civilian test evaluator, during a deployment readiness review last summer. The Coyle Report describes in detail many critical flaws in the plan to test the missile defense system for effectiveness.

This analysis summarizes the Coyle Report. The analysis was requested by Rep. John F. Tierney, a member of the Subcommittee on National Security, Veterans Affairs, and International Relations of the House Government Reform Committee. Specifically, Rep. Tierney requested a description of the major issues raised in the Coyle Report, as well as a full list of the recommendations set forth in the report (included as Appendix A).

The Coyle Report finds that the missile defense system's effectiveness is not yet proven, even in the most elementary sense. According to the report, the program is too immature to assess its effectiveness or to predict potential deployment dates. In addition, the program fails to test basic elements of the system, such as countermeasures or multiple engagements, which are expected to be the norm. The report also finds that the system will not be able to defend against accidental or unauthorized launches. Tests that have been conducted to date have been made progressively easier rather than more challenging, and they have relied on artificially "canned" scenarios that provide advance information that will be unavailable in actual engagements.

The Coyle Report also raises new concerns with premature deployment. For example, the report describes a phenomenon experienced in simulation exercises called "phantom tracks." As the report explains, the system accidentally launched several interceptors against missiles that did not exist. Although operators attempted to take emergency actions to override these launches, they were unsuccessful in all cases. This and other potential malfunctions suggest that deploying prematurely a system that has not been fully tested to meet an arbitrary deadline could pose increased risks to global stability and security.

The Department of Defense has tried repeatedly to keep the Coyle Report confidential. Despite numerous requests from Rep. Tierney, the Pentagon refused to deliver the report for over eight months, disregarding a statute requiring that the report be provided to Congress. The Pentagon delivered the report only after 55 members of Congress, including the ranking minority members of three congressional committees, wrote to Secretary of Defense Donald Rumsfeld. Even then, however, the Pentagon's official position remained that the public should be denied access to this information.

## I. Origins of the Coyle Report

### A. Preparation of the Report by the Office of Operational Test and Evaluation

The Subcommittee on National Security, Veterans Affairs, and International Relations of the House Committee on Government Reform has obtained an internal Pentagon report that is critical of the missile defense program.[1] This report was written by Philip Coyle, the former Director of Operational Test and Evaluation within the Department of Defense. Mr. Coyle conducted his evaluation during the Deployment Readiness Review last summer.

The office of Operational Test and Evaluation is an independent assessment office within the Pentagon. It was created to oversee testing programs and, in particular, to ensure that weapons development programs are adequately tested in realistic operating conditions. It was established in 1983 in legislation sponsored by Senators David Pryor and William Roth. This bill removed testing oversight authority from military officials and lodged it with a civilian director after repeated deployments of immature weapons systems.[2]

One of the primary purposes of the office of Operational Test and Evaluation is to provide independent analyses to Congress. According to the law establishing this office:

> The Director [of the testing office] shall comply with requests from Congress (or any committee of either House of Congress) for information relating to operational test and evaluation in the Department of Defense.[3]

### B. First Congressional Requests for the Coyle Report

Rep. Tierney and other members of the National Security Subcommittee first learned about the Coyle Report at a hearing on September 8, 2000. During that hearing, Mr. Coyle testified about major deficiencies in the missile defense testing program.[4] Rep. Tierney asked Mr. Coyle to provide his complete report for the record, and Mr. Coyle agreed. Rep. Tierney also made an official request to include the Coyle Report in the Subcommittee's public hearing record. This motion was accepted without objection.

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[1]Philip Coyle, *Operational Test and Evaluation Report in Support of National Missile Defense Deployment Readiness Review* (Aug. 10, 2000) (hereinafter "Coyle Report").

[2]*Pentagon Weapons Testing Move is Assailed,* Washington Post, A14 (Dec. 15, 1983) ("Congress established an independent office after hearing testimony that backers of new weapons in the Pentagon authorize production of weapons that do not work and have not been reliably tested.").

[3]10 U.S.C. §139(g).

[4]Subcommittee on National Security, Veterans Affairs, and International Relations, Committee on Government Reform, *Hearing on National Missile Defense: Test Failures and Technology Development,* 106th Cong. (Sept. 8, 2000).

At no time during the hearing did either Mr. Coyle or Lieutenant General Ronald Kadish, the director of the missile defense program and also a hearing witness, express any reservation about Rep. Tierney's request for the report.

### C. Further Congressional Efforts To Obtain the Coyle Report

The Department of Defense did not comply with the Subcommittee's request. Rep. Tierney wrote to Rep. Christopher Shays, Chairman of the Subcommittee, and requested that Mr. Coyle "submit for the record his formal report."[5] In a subsequent letter to the Department of Defense, Chairman Shays also made clear that the report could be "included in the official hearing record."[6]

After four months with no response from the Department, Rep. Tierney sent another letter to Chairman Shays. In this letter, Rep. Tierney requested that the Subcommittee subpoena the Coyle Report, again recounting that it "would be included in the hearing record."[7] Chairman Shays chose not to issue a subpoena.

Rep. Tierney then joined 54 other members from the Committees on Government Reform, Armed Services, and International Relations in sending a request to Secretary of Defense Donald Rumsfeld. In that letter, these members again made clear the importance of the report, as well as their intent to make it public:

> Mr. Coyle agreed to make the report available to the Subcommittee, which voted unanimously to make it part of the hearing record . . . . You are requested to deliver Mr. Coyle's report to the Subcommittee forthwith, in its entirety, and without alteration.[8]

### D. Production and Release of the Coyle Report

Finally, more than eight months after the initial request, the Department delivered the report on May 31, 2001. No explanations were provided to Subcommittee members regarding the Department's refusal to honor earlier Subcommittee requests. In producing the Coyle Report, Pentagon officials informed the National Security Subcommittee that it should be kept confidential. In a cover letter conveying the report to the Subcommittee, the Department's legal counsel stated that they were providing the report "as a matter of discretion for use by the

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[5]Letter from Rep. John Tierney to Chairman Christopher Shays (Sept. 28, 2000) (emphasis added).

[6]Letter from Chairman Christopher Shays to Lieutenant General Ronald Kadish (Oct. 4, 2000) (emphasis added).

[7]Letter from Rep. John Tierney to Chairman Christopher Shays (Jan. 24, 2001) (emphasis added).

[8]Letter from Rep. John Tierney and 54 Other Members of Congress to Secretary of Defense Donald Rumsfeld (May 4, 2001) (emphasis added).

committee for its oversight purposes only."[9] This letter stated further that the Department "has not approved the release of this report to the general public."[10]

The basis for the Pentagon's request for confidentiality is unclear. There has never been any claim that the Coyle Report is classified, either in its entirety or with respect to any of its contents (*i.e.,* data, charts, or other information). The Department had substantial time to review the document for national security or other sensitive information and made no such determinations. Moreover, there were no claims that the document contained personal financial information, medical information, or confidential business information, and the Pentagon never claimed that the report contained errors or misstatements of fact.

To provide an opportunity to explain the Department's rationale for suppressing the Coyle Report, Rep. Tierney wrote to Secretary Rumsfeld to seek a detailed justification of the Department's actions. Although an official from the Secretary's legislative office called to reiterate the Department's general desire to suppress the report, the Pentagon otherwise was unresponsive. As a result, the Chairman of the National Security Subcommittee denied the Pentagon's request to suppress the report and made the report available to the public pursuant to the motion previously adopted by the Subcommittee.

## II. Critical Deficiencies in the Testing Program

The Coyle Report raises fundamental problems with the missile defense testing program. The report details how the Pentagon, after numerous failures, altered the test program to make it easier. The report also describes how the Department, realizing the technical limitations of the system, discarded and downplayed previous testing goals. Despite these changes, the report finds that the program continued to fail repeatedly.

### A. Inability To Assess Immature Program

As a general proposition, the Coyle Report explains that the system is too immature to assess in terms of predicting a realistic deployment date. This is because "[n]one of the major NMD [National Missile Defense] elements . . . are mature enough to provide an adequate performance evaluation," according to the report.[11] Throughout the report are numerous statements describing the immature status of the program:

> Given the immaturity of ground testing, the delays in ground-test capabilities, the limitations in flight testing, and the inadequacy of available simulations, a rigorous assessment of potential system performance cannot be made. That is, no one can reliably

[9]Letter from Stewart F. Aly, Acting Deputy General Counsel (Legal Counsel) to Chairman Christopher Shays (May 31, 2001).

[10]*Id.*

[11]Coyle Report, *supra* note 1, at 46.

predict that the NMD system will perform at the [required] levels.[12]

> The NMD system's ability to defend all fifty states from attacks . . . can not be satisfactorily assessed, primarily because the simulations that were to demonstrate this with confidence and high fidelity have not developed as planned.[13]

> [T]he ability to perform a credible assessment of NMD design maturity is confounded by the current immature state of ground test facilities and models and simulations.[14]

Part of the reason an assessment cannot be done is that test failures have caused delays. The report states that the third integrated flight test was conducted 18 months late, the first boost vehicle test was delayed a year, and contract authorizations have been put off as a result. The report explains that "[d]elays in the flight test program are the most visible, but developmental problems in simulation and ground test facilities may have an even greater impact."[15]

In an attempt to predict a potential deployment date in light of these delays, the report calculates that the program is "slipping at a rate of 20 months every three years."[16] During the hearing before the National Security Subcommittee, Mr. Coyle estimated that the program would not be ready to deploy until 2011.[17]

### B. Failure To Test against Countermeasures

The Coyle Report finds that no analyst can conclude presently that the system will work. It also describes several ways the system may not work. One of the system's key technical problems is its inability to defend against decoys. The report considers "discrimination" against countermeasures the system's greatest challenge:

> Discrimination is perhaps the most challenging aspect of national missile defense. As discussed extensively in open literature, the enemy could employ various types of countermeasures to overwhelm this function.[18]

> Decoys that provide a close representation of the RV [Reentry Vehicle] or modify the RV

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[12]*Id.* at 42 (emphasis in original).

[13]*Id.* at 4.

[14]*Id.* at 5.

[15]*Id.* at 8.

[16]*Id.* at 9.

[17]Hearing Transcript, *supra* note 4.

[18]Coyle Report, *supra* note 1, at 49.

signature have only been minimally investigated.[19]

Potential adversaries may use a variety of countermeasures, ranging from relatively unsophisticated decoys to more sophisticated measures. Currently, the program includes flight tests with only a single balloon decoy — the simplest of countermeasures. The report warns that the test program "does not consider other simple unsophisticated countermeasures" which are "simple to implement, *e.g.,* tumbling RVs and non-spherical balloons."[20]

There are also no flight tests against more mature countermeasures that rogue states could purchase or otherwise acquire. According to the report, "the ability to discriminate more sophisticated countermeasures needs special consideration. Discrimination is a high-risk area that if left unresolved could prevent NMD from meeting its requirements."[21]

### C. Failure To Defend against Accidental Launches

By omitting flight tests with countermeasures other than simple balloons, the system will be unable to fulfill another of its core functions — to defend against accidental or unintended launches. According to the Coyle Report, officials originally designing the architecture for the missile defense system developed 13 different scenarios the system would have to defeat in order to be effective.[22] The clear emphasis in these scenarios was on accidental or unintended launches from countries such as Russia or China. Only four scenarios involved rogue states, while nine "postulated accidental or unauthorized launches by the major declared nuclear powers."[23]

It is widely recognized, however, that missiles accidentally fired from Russia or China will be armed with some of the most sophisticated countermeasures available. The report finds that the test program ignores this possibility and foregoes flight tests for these countermeasures. According to the report, "the target suites in flight tests will have at most unsophisticated countermeasures, even though the threat from accidental or unauthorized launches could employ sophisticated countermeasures."[24]

Recognizing this deficiency, the Pentagon began to backtrack on the importance of defending against accidental launches. According to the report, "[t]he NMD Program's focus appears to have shifted to the threat posed by North Korea with the accidental/unauthorized

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[19] *Id.* at 57.

[20] *Id.* at 5.

[21] *Id.* at 49.

[22] *Id.* at 6.

[23] *Id.*

[24] *Id.* at 19.

threat becoming a secondary consideration."[25]

In this way, the Department of Defense acknowledged implicitly that the system will not be able to defend against sophisticated countermeasures that are widely available. In fact, according to the report, the latest statements from the Pentagon omit altogether any mention of accidental launches from established nuclear powers. According to the report, "[t]he recently issued Defense Planning Guidance Update FY2002-2007 goes further, defining the purpose of NMD in terms of only rogue nations."[26]

### D. Failure To Test against Multiple Engagements

The current test program has no plans to test other, extremely basic elements of the system, according to the Coyle Report. The system does not test against multiple targets or interceptors, for example, even though "multiple engagements are expected to be the norm."[27] Such testing is critical for discerning "unanticipated synergistic effects" between simultaneously deployed interceptors.[28] The report concludes that "many questions or issues simply cannot be resolved from the testing of 1-on-1 engagements."[29] Again, the report criticizes the current test program for its lack of realism and its inability to provide useful assessment information:

> Since such engagements are expected to be common during NMD missions, this capability will need to be demonstrated in an integrated flight test before [Initial Operational Capability]. Such engagements are currently not included in the defined test plan.[30]

The report emphasizes that these types of multiple engagement tests are critical "as too many technical challenges to the system exist beyond merely the command and control software."[31] For that reason, tests must be conducted in actual flight tests. The report raises four core questions in this respect:

1. How will an EKV [Exoatmospheric Kill Vehicle] respond to another EKV in its field of view, or multiple RVs [Reentry Vehicles] in its field of view?

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[25] *Id.* at 6.

[26] *Id.* (emphasis added).

[27] *Id.* at 20.

[28] *Id.*

[29] *Id.*

[30] *Id.* at 53.

[31] *Id.* at 54.

2. How is the performance of an EKV seeker affected by a thrusting EKV or another EKV intercepting an object in its field of view?

3. Can the X-Band radar simultaneously track multiple RVs that require different antenna orientations?

4. Can the IFICS [In-Flight Interceptor Communications System] communicate with multiple KVs [Kill Vehicles]?[32]

According to the report, these questions must be answered in flight tests before the system enters initial operational test and evaluation — not after deployment.[33]

### E. Dumbing-Down Test Requirements

As in the case of accidental launches, there are other instances in which the Pentagon has chosen to ignore fatal errors rather than remedy them. For instance, the Department has been making flight tests easier rather than more difficult. According to the Coyle Report:

> The target suites flown in IFTs [Integrated Flight Tests] 3, 4, and 5 each contained only two objects — a Medium Reentry Vehicle (MRV) and a Large Balloon — a significant reduction in complexity from the original plan. Target requirements . . . called for nine to ten objects in flight tests IFT-1 through IFT-5, suites that contained both unsophisticated and sophisticated decoys. In 1998, target requirements were pared down to three balloons (one large and two small balloons) and the MRV. Then, in July 1999, less than three months before IFT-3, the target suite was further reduced to two objects, as indicated above.[34]

Now, instead of discriminating the reentry vehicle from nine or ten decoys, the system tests only against a reentry vehicle and one decoy — a large balloon that "does not mimic in any way the current test RV."[35] In fact, the report warns that not even one flight test will include "objects with radar signatures designed to mimic those of the [reentry vehicle]."[36]

This process of dumbing down requirements has not prevented additional test failures. Indeed, during a flight test last summer, even the single balloon decoy failed to deploy. According to the report, the balloon "was never deployed because of some unknown failure of

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[32] *Id.* at 54.

[33] *Id.* at 55.

[34] *Id.* at 19 (emphasis added).

[35] *Id.* at 53.

[36] *Id.* at 44.

the deployment mechanism."[37] The report calls for an immediate halt to this practice. It recommends discarding the balloon decoy and employing "multiple decoys designed to mimic the RV radar signature."[38]

### F. Testing against "Canned" Scenarios with *A Priori* Information

According to the Coyle Report, the Department has been providing interceptors with key information ahead of time. The report explains that interceptors were "provided with detailed information about the target suite — required to execute the discrimination algorithm — before the flight test was performed."[39] Because the system will not have the benefit of advance information once deployed, the report recommends that "[r]ehearsed engagements with *a priori* knowledge of target complex, target trajectory, and time of launch need to be discontinued during operational testing."[40] Despite the need for more rigorous testing, the report finds that "there are no plans as yet to withhold detailed information about target signatures in an intercept test."[41]

In another example of flawed testing, the report criticizes the simulations software. According to the report, the contractor's software suffers from the same drawbacks as the flight tests — an unfounded reliance on unrealistic, inflexible, and overly optimistic parameters:

> Boeing will provide users with canned scenarios, including fixed launch points, aim points, ICBMs, debris, and apogees. The Operational Test Agencies had been planning to run hundreds of digital simulation scenarios, varying such parameters as raid size, trajectories, atmospherics, debris, nuclear effects, threat launch and impact points, threat types, and Penetration Aids (PENAIDS). [The simulator] will not have the flexibility to support such studies.[42]

The report is highly critical of this software, stating that "it is practically a hard-wired simulation that only the Boeing developers can modify."[43] Instead, the report recommends a more realistic approach:

> LIDS [the simulation program] needs to evolve to a fully validated high fidelity simulation. It should be flexible enough to allow both DOT&E [the Director of

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[37] *Id.* at 28.

[38] *Id.* at 54.

[39] *Id.* at 44.

[40] *Id.* at 54.

[41] *Id.* at 44 n.29.

[42] *Id.* at 35-36.

[43] *Id.* at 56.

> Operational Test and Evaluation] and Service Operational Test Agencies to examine . . . areas of sensitivity or design margin analysis.[44]

The report notes, however, that there is "no apparent plan by the LSI [Boeing] to do this."[45]

### G. "Phantom Tracks"

In addition to documenting deficiencies in the testing program, the Coyle Report also describes dangers that could arise from prematurely deploying a technically immature system. One problem raised in the report concerns a phenomenon in the simulation program described as "phantom tracks." According to the report, phantom tracks arise during the transition process from one radar to another. In this "handover" process, the system mistakenly interprets one radar signal as two — one real and one phantom:

> Phantom tracks arise when radar coverage . . . transitions from one radar to a second (known as "handover"), and the [system] mistakenly interprets the new radar returns as originating from a second RV.[46]

> In other words, the track of the "old" threat object splits into two tracks thereby creating a phantom track.[47]

When this occurs, the system "automatically allocate[s] interceptors against this phantom object."[48] The report explains how operators engaged in these simulations tried to take emergency actions: "When NMD operators believed that interceptors were allocated against phantom tracks, they tried a variety of techniques to override the automated battle manager."[49] According to the report, this malfunction was "particularly frustrating" and made operators "anxious" because "there was no tool that could definitively warn operators when a phantom track appeared."[50] The report concluded: "Although such actions should have worked, they were unsuccessful in all cases. The system simply was not behaving according to operator actions."[51]

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[44] *Id.* at 56.

[45] *Id.* at 57.

[46] *Id.* at 48.

[47] *Id.* at 33.

[48] *Id.*

[49] *Id.* at 34.

[50] *Id.*

[51] *Id.* (emphasis added).

## III. RECOMMENDATIONS

The Coyle Report sets forth over 50 recommendations. They involve issues such as testing complexity, testing artificiality, and operational realism. They also cover the full spectrum of the test program, including flight tests, ground tests, simulations, and programmatic issues, such as performance criteria and risk reduction efforts. A list of these recommendations is attached to this report as Appendix A.

## APPENDIX A
## List of Recommendations in Coyle Report

The Coyle Report sets forth over 50 recommendations. These recommendations are quoted below. They are numbered for convenience, and page references are provided in parentheses.

1. Flight testing . . . needs to aggressively increase in complexity to keep pace with NMD [National Missile Defense] C1 [Capability 1] development and to adequately stress design limits, particularly for the missile system. (p. 53)

2. Target suites used in integrated flight tests need to incorporate challenging unsophisticated countermeasures that have the potential to be used against the NMD C1 [Capability 1] system (e.g., tumbling RVs [Reentry Vehicles] and non-spherical balloons). (p. 53)

3. Use of the large balloon should be discontinued, as it does not mimic in any way the current test RV [Reentry Vehicle]. (p. 53)

4. True decoys that attempt to replicate RV [Reentry Vehicle] signatures as well as balloon-type countermeasures that have been examined by the Countermeasures Hands-On Program (CHOP) need to be integrated into flight test target suites. (p. 53)

5. Engagement times of day and solar position need to be planned to stress the acquisition and discrimination process by all of the sensor bands. (p. 53)

6. [T]he effects of weather on radar, telemetry and satellite operations need to be tested either during intercept or risk reduction flight tests or other targets of opportunity. Radar discrimination, IFICS [In-Flight Interceptor Communications System] transmission/ reception, and DSP/SBIRS [Defense Support Program/Space Based Infrared System] launch detection may be operating at their technical limits, and heavy rain or dense cloud conditions may have significant effects on their performance. (p. 53)

7. Category B engagements are engagements in which an interceptor is launched against a target cluster (based on radar track) before the threat RV [Reentry Vehicle] is resolved and discriminated. Since such engagements are expected to be common during NMD missions, this capability will need to be demonstrated in an integrated flight test before IOC [Initial Operational Capability]. Such engagements are currently not included in the defined test plan. (p. 53)

8. Multiple engagements will be the expected norm in tactical situations, therefore, simulated extrapolation from 1-on-1 scenarios to M-on-N need to be validated through intercept flight testing. (p. 53-54)

9. Multiple engagements of at least 2-on-2 scenarios need to be flight tested, as too many technical challenges to the system exist beyond merely the command and control

software. (p. 54)

10. Identifying the impact of the interaction of one kill vehicle to another and assessing the performance of ground tracking systems in M-on-N scenarios lead to several questions:

    a. How will an EKV [Exoatmospheric Kill Vehicle] respond to another EKV in its field of view, or multiple RVs [Reentry Vehicles] in its field of view? (p. 54)

    b. How is the performance of an EKV [Exoatmospheric Kill Vehicle] seeker affected by a thrusting EKV or another EKV intercepting an object in its field of view. (p. 54)

    c. Can the X-Band radar simultaneously track multiple RVs [Reentry Vehicles] that require different antenna orientations? (p. 54)

    d. Can the IFICS [In-Flight Interceptor Communications System] communicate with multiple RVs [Reentry Vehicles]? (p. 54)

11. Radar discrimination with limited *a priori* knowledge of the target complex needs to be flight tested prior to the FY01 radar decision. This type of test ("pop quiz" type) of flight test needs to be executed, at least during a risk reduction flight. (p. 54)

12. This test should employ multiple decoys designed to mimic the RV [Reentry Vehicle] radar signature but should not provide unrealistic detailed target or decoy information to the GBR-P [Ground Based Radar-Prototype] radar prior to the engagement. (p. 54)

13. Current test range limitations need to be removed to adequately test the NMD system. (p. 54)

14. Use of the FPQ-14 range radar as the source of Weapon Task Plan data needs to be phased out. (p. 54)

15. Target trajectories or radar surrogate locations need to be changed to permit the organic NMD system to provide early radar cueing with the appropriate degree of position and velocity accuracy. (p. 54)

16. Engagement geometries need to be devised that will provide higher speed engagement conditions for the EKV [Exoatmospheric Kill Vehicle], as would be expected in the C1 [Capability 1] timeframe with the tactical booster. (p. 54)

17. Avoidable limitations to operational realism must be removed before conduct of the IOT&E [Initial Operational Test and Evaluation]. (p. 54)

18. Rehearsed engagements with *a priori* knowledge of target complex, target trajectory, and time of launch need to be discontinued during operational testing. (p. 54)

19. Situations employing a lack of *a priori* knowledge also need to be examined in DT [Development Testing] to assure acquisition and discrimination algorithms are properly designed. (p. 54-55)

20. The flight testing artificialities addressed above must be eliminated for IOT&E [Initial Operational Test and Evaluation]. (p. 55)

21. Alternative intercept test scenarios must be devised that employ inbound or crossing targets rather than outbound relative to the Early Warning Radar. (p. 55)

22. GPS [Global Positioning System] and midcourse radar tracking using a transponder cannot be used by the NMD system to perform its mission. The Weapon Task Plan must be prepared based on organic NMD tracking systems. (p. 55)

23. Options for higher speed intercepts must be investigated. (p. 55)

24. Deployed element usage needs to be maximized for IOT&E [Initial Operational Test and Evaluation]. The X-Band Radar and/or Upgraded Early Warning Radar should be used. (p. 55)

25. Deployed IFICS [In-Flight Interceptor Communications System] ground antennas and tactical communications should also be tested as part of the IOT&E [Initial Operational Test and Evaluation]. (p. 55)

26. Multiple engagements must be accomplished during IOT&E [Initial Operational Test and Evaluation]. (p. 55)

27. [Multiple engagements] should be flown in IFTs [Integrated Flight Tests] before IOT&E [Initial Operational Test and Evaluation] to maximize the chance of success in IOT&E. (p. 55)

28. Plans for providing spares should be developed, especially for targets where current target components can be as much as 30 years old. (p. 55)

29. Adequate GBI [Ground Based Interceptor] booster spares need to be procured as a risk reduction effort, to preclude further schedule slip should a failure occur in preflight booster testing. (p. 55)

30. NMD is currently employing what is referred to as a "rolling spare" concept for its targets. It can take up to six weeks to prepare for and reset the IFT [Integrated Flight Test] launch date. A "hot spare" approach for which an additional target is prepared at the target launch site would eliminate the need to stand down operations at the interceptor launch site in the event of a failed target launch. This could be more significant as flight testing becomes more complex or critical, such as in the small number of OT [Operational Test] shots, when a failed target launch might be much more costly to the program. The delay to the target launch during IFT-5 [Integrated Flight Test 5] is a

strong example of this potential problem. If the last minute target problems could not have been corrected, IFT-5 would have slipped an additional month. (p. 55)

31. An innovative new approach needs to be taken towards HWIL [Hardware-in-the-Loop] testing of the EKV [Exoatmospheric Kill Vehicle], so that potential design problems or discrimination challenges can be wrung out on the ground in lieu of expensive flight tests. (p. 56)

32. HWIL [Hardware-in-the-Loop] development needs to focus on the EKV [Exoatmospheric Kill Vehicle], since this is the most challenging technical area for NMD hit-to-kill. (p. 56)

33. Funding and development needs to be accelerated or the required capability in this area will not be available to support C1 [Capability 1] testing. (p. 56)

34. The HWIL [Hardware-in-the-Loop] facility and test approach needs to be done at the highest level of EKV [Exoatmospheric Kill Vehicle] system integration available, so that all component interaction, from sensors to the divert systems, can be examined simultaneously. (p. 56)

35. An innovative approach should be taken that provides an interactive scene generation capability that adapts to changes in EKV [Exoatmospheric Kill Vehicle] and target aspect angles. (p. 56)

36. Scene generation should have the capability to challenge target acquisition by the EKV [Exoatmospheric Kill Vehicle], discrimination and homing algorithms with anticipated or potential countermeasures. (p. 56)

37. Current analysis of exoatmospheric lethality is limited to computer simulations and light gas gun tests. New techniques or facilities need to be developed to achieve higher speed intercepts on the ground in full scale to validate hydrocode simulations and 1/4 scale light gas gun tests. (p. 56)

38. Investments need to be made in the Holloman High Speed Test Track to permit lethality testing of medium to high fidelity representations of the kill vehicle to at least the low end of the range of potential intercept velocities. (p. 56)

39. LIDS [Lead System Integrator Distributed Simulation] development has taken much longer than originally promised. Additionally, it is practically a hard-wired simulation that only Boeing developers can modify. This precludes independent, Government sensitivity analysis and assessment. LIDS needs to evolve to a fully validated high fidelity simulation. (p. 56)

40. [The Lead System Integrator Distributed Simulation] should be flexible enough to allow both DOT&E [Director of Operational Test and Evaluation] and Service Operational Test Agencies to examine subsystem drop-outs and graceful degradation or other areas of

sensitivity or design margin analysis. There is currently no apparent plan by the LSI [Lead System Integrator] to do this. (p. 56-57)

41. Discrimination by the radar and weapon system (EKV [Exoatmospheric Kill Vehicle]) should be given more weight in performance criteria. All other aspects of the NMD performance requirements appear to be within the state of the art of technology. Discrimination by the EKV on the other hand will be the biggest challenge to achieving a hit-to-kill intercept. Decoys that provide a close representation of the RV [Reentry Vehicle] or modify the RV signature have only been minimally investigated. (p. 57)

42. The NMD requirements for reliability, availability, and effectiveness are specified in the NMD ORD [Operational Requirements Document]. When these requirements are allocated to the individual elements of the NMD system, the resulting reliability performance standards are unrealistically high as well as difficult to test. As the program develops, it may be necessary to re-examine the overall requirements for NMD reliability and availability. (p. 57)

43. Minuteman Missile OPEVAL [Operational Evaluation] testing needs to continue to be leveraged, not only for IFT [Integrated Flight Test] rehearsal, but also to look at the impact of countermeasures to ground radar systems. (p. 57)

44. Ballistic Missile Critical Measurements Program tests need to be conducted to examine countermeasure signatures and discrimination algorithms. (p. 57)

45. BMDO [Ballistic Missile Defense Organization] sponsors a red team approach to the possible development of countermeasures. Operated at very modest funding levels, CHOP [Countermeasures Hands-On Program] develops and demonstrates ROW [Rest-Of-World] countermeasures that could be challenging for U.S. missile defense systems. By charter, CHOP does not try to develop "sophisticated" countermeasures. However, the unsophisticated, ROW countermeasures they do develop are realistic and challenging and should be included as an integral part of the NMD flight testing and ground test HWIL [Hardware in the Loop] simulations programs. (p. 57-58)

46. The CHOP [Countermeasures Hands-On Program] program needs to be supported for aggressively examining the potential of states of concern to develop more sophisticated countermeasures. (p. 58)

47. The Defense Intelligence Agency (DIA) needs to begin tracking CHOP [Countermeasures Hands-On Program] experiments. (p. 58)

48. [The Defense Intelligence Agency] should then investigate and bound the ability of states of concern to develop and apply the technologies that the CHOP [Countermeasures Hands-On Program] teams use in their experiments to counter an NMD system. (p. 58)

49. This information should then be fed back to CHOP [Countermeasures Hands-On Program] management for planning and executing CHOP developments. (p. 58)

50. The NMD Program Office chartered a red team to look at OPINE [Operations in a Nuclear Environment] testing and facility requirements for the EKV [Exoatmospheric Kill Vehicle]. The red team found the Raytheon-proposed test and parts screening program to be inadequate. OPINE testing needs to be conducted at the EKV system level in nuclear environments that replicate expected operational conditions, including expected flux levels. (p. 58)

51. OPINE [Operations in a Nuclear Environment] test facilities at Aberdeen Proving Ground and Arnold Engineering Development Center need to receive appropriate and timely funding to support EKV [Exoatmospheric Kill Vehicle] OPINE testing required to begin in FY02. (p. 58)

52. The NMD Program Office should investigate lethality enhancement options for dealing with potential countermeasures, using relatively simple techniques, that try to alter the effective RV [Reentry Vehicle] size or shape in an attempt to foil discrimination and aimpoint selection. (p. 58)